ISSUE BRIEF

Building resilience to water induced hazards in Gilgit–Baltistan: Experiences from the Community Based Flood Early Warning System

KEY MESSAGES

Since Gilgit–Baltistan is highly prone to floods, there is a pressing need for disaster preparedness in this territory.

The Community Based Flood Early Warning System (CBFEWS) is effective in flood-related disaster preparedness as it provides real-time early warning and sufficient lead time to the vulnerable communities.

One of the key factors in the successful adoption and sustainability of CBFEWS is the involvement and mobilization of the relevant stakeholders at the very initial stage.

1. Hazards induced by climate change: Pakistan's context

The mountainous regions of the Hindu Kush Himalaya (HKH) are currently facing rapid environmental changes due to a combination of natural and anthropogenic factors. Pakistan, one of the countries in the HKH, was listed in the "Very High" category in the Climate Risk Index for 1998–2017.[1] It is also one of the five South Asian countries with the highest annual average number of people physically exposed to flood risks.

For instance, the 2010 floods in Pakistan are considered to be a watershed event in terms of not only the magnitude of the impact[2,3] but also in terms of disaster preparedness.[4] Similar flood intensities were also observed in the next three years, from 2011 to 2013, where the damages to agriculture and infrastructure were severe.[5] These had grave consequences for Pakistan's economy.

2. Gilgit–Baltistan: Vulnerability to climate change

Gilgit–Baltistan is an upstream source of crucial watersheds within Pakistan, including the Indus River basin. The territory also houses some of the most vulnerable mountain communities as far as water-induced hazards are concerned. The risk of such hazards in Gilgit–Baltistan has to do with changing climatic patterns in the form of rising temperatures (which cause glacial melt at a faster pace), heavy snowfall in the winters, and unpredictable precipitation

levels during the summers. These have triggered increasing landslides, flash floods, and debris flows, wreaking havoc on both infrastructure and agriculture.

These days, among the populace of Gilgit–Baltistan, there is increasing concern about disaster events like flash floods (Table 1). Many of the elders there attribute this to the erratic nature of rainfall; they also point out that the courses of streams have shifted leading to flooding in new locations.

> "Due to the huge volume of floods and their changing directions, the local communities cannot do anything but move to temporary areas in adjacent villages. In doing so, many also take their moveable properties and livestock with them."
>
> *– Ghulam Muhammad, resident, Ghanche*

2.1 WHY CBFEWS?

The Sendai Framework's indicators that measure the progress on the implementation of disaster risk reduction (DRR) have provisions for the need of early warning systems. Under its "Global Target G" (concerning early warning and risk information), the framework calls for an increase in the number of such systems as well as of people that have access to effective early warning information.[6] In recognition of this, the Government of Pakistan's National Disaster Management Plan (NDMP) has outlined the need to increase and strengthen the mechanisms of early warning systems in a phase-wise manner for 2012–2022.

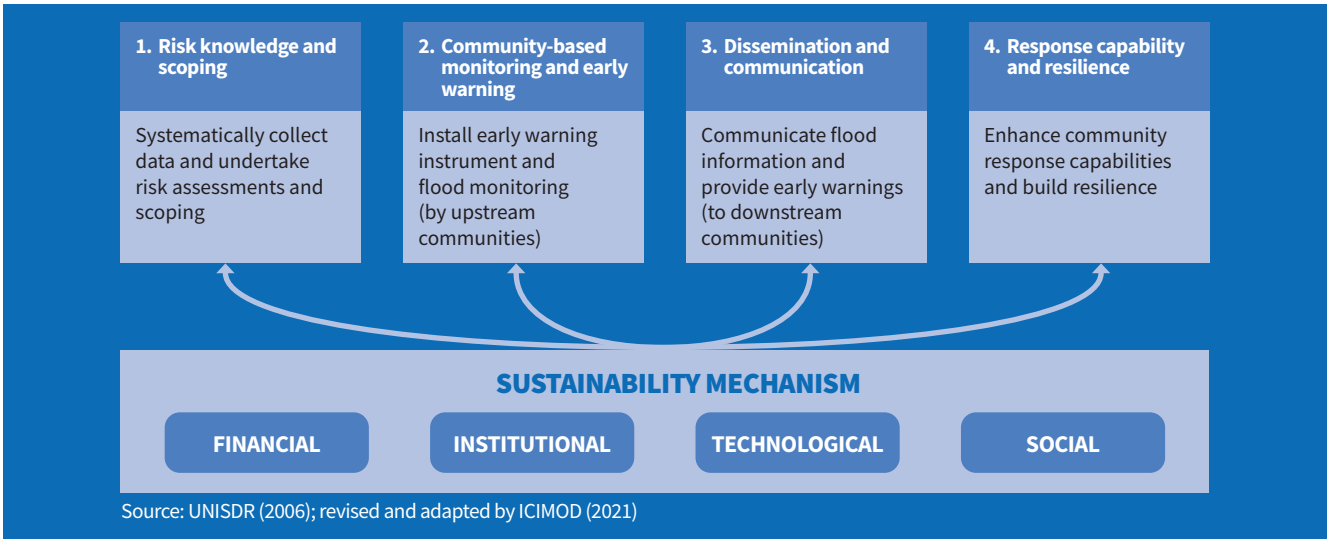
The basic purpose of flood early warning systems is to issue timely warnings to communities and other stakeholders about an imminent flood or debris flow. In general, early warning systems are built around the assessment and knowledge of flood risks at a site, water-level monitoring and warning service, flood-risk dissemination and communication service, and the enhancement of community-response capabilities. The systems are designed to increase the level of community preparedness towards extreme weather events, in terms of both warning and improving understanding about risks and appropriate responses (UN Environment-DHI Centre). In CBFEWS, the community component is an integral part (Figure 1). The experience from ICIMOD's pilot sites in Pakistan have shown how sustained partnerships among the vulnerable communities in the flood-prone areas of the Upper Indus basin played a key role in providing real-time early warning information and thereby saved lives (read more in the Sherqilla success story box).

TABLE 1 **MAJOR COMMUNITY-LEVEL FLOOD DISASTERS IN GILGIT–BALTISTAN BETWEEN 2010 AND 2020**[7,8]

Tehsil	Village	Event	Year	Number of houses damaged
Gilgit	Kargah Nalah, Kono Das, Juglot (Goro), Basin/Jagir Basin, Shirote/Shikyote, Saeedabad (Thini), Rahimabad, Aminabad-Nomal, Jutal, Bargo, Kashrote, Konadas, Henzal	Flash flood	2010	590
Diamar	Khinar, Gas Bala	Flash flood	2010	485
Skardu	Shigar, Qumra, Sermik	Flash flood	2010	92
Yasin	Darkuth, Gojulti, Hundur, Damalgan, Gitch, Umelsaath, Nilth	Flash flood	2010	77
Kharko	Garbong	Flash flood	2010	66
Ishkoman	Chatorkand, Birgal, Daeen, Imit, Assumbar, Aminabad, Pakora, Gutolti	Flash flood	2010	65
Gupis	Gupis, Shamaran, Shonas, Sarolokoto	Flash flood	2010	25
Immit Valley	Badswat and Bilhanz villages	Glacial lake outburst flood (GLOF)	2018	40
Hasanabad	Shishper	GLOF	2019, 2020	20
Gojal	Chamagul Gulmit, Chipursan	Flash flood	2010	17
Ishkoman	Badswat	Flash flood	2015	10
Gojal	Ghulkin	GLOF	2008, 2010, 2013	20

Source: Aga Khan Agency for Habitat

FIGURE 1 KEY ELEMENTS FOR CBFEWS IMPLEMENTATION

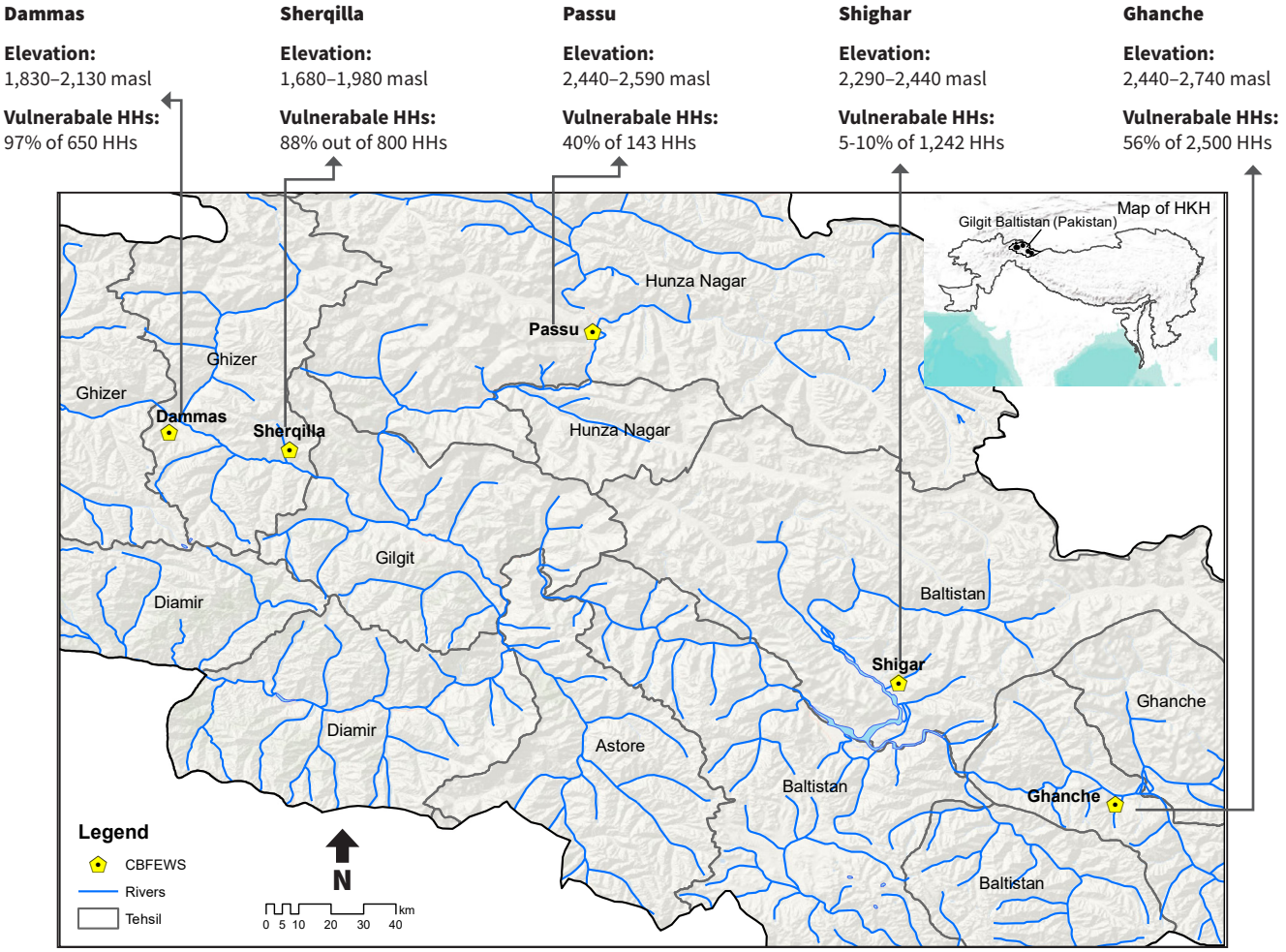


Source: UNISDR (2006); revised and adapted by ICIMOD (2021)

3. Pilot sites in Gilgit–Baltistan

Starting as a reconnaissance survey in 2014, the primary objective of the CBFEWS pilots was to not only assess the areas where the systems would be established but also to decide on the suitable equipment for each of the selected sites. In all, five pilot sites – Sherqilla, Damas, Passu, Shigar, and Khaplu – were chosen based on a combination of factors pertaining to the vulnerability of communities and the feasibility of installations of the wireless systems (Figure 2).

FIGURE 2 COMMUNITY BASED FLOOD EARLY WARNING SYSTEM



The risk assessment for the CBFEWS sites was carried out using a combination of household data collection and analysis of the types of hazards a community would be vulnerable to. In addition, other factors like the severity and duration of hazards were assessed to provide a complete picture of the likely factors that would affect communities in case of a disaster. Moreover, safe evacuation zones were also scoped out for the communities.

While all the sites yielded similar characteristics in terms of vulnerability to hazards, the selection of instruments was governed by the flood type (Table 2). The Gilgit–Baltistan communities were particularly concerned about the increase in flood events, debris flow, and landslides. For example, the site in Damas was found to be vulnerable to debris flow from the adjoining glaciers, while the Shigar tributary brings in large deposits of debris during the peak-flow season, thereby impacting households located in its vicinity.

TABLE 2 **DISASTER PROFILES OF THE FIVE PILOT SITES**

DISASTER PROFILE OF DAMMAS

Settlement	Year	Event and cause	Nallah	Losses
Dammas	1975	Flood due to heavy rains and intensive snowmelt	Dirani Nallah	Farmlands, fruit trees, and timber trees
Hasis	1983	Debris flow due to heavy rains	Hasis Nallah	No damages
Hasis	2010	Flash flood	Phamani and Hasis Nallah	7 fully damaged houses and washed-out farmlands
Golodass	2010	Heavy rainfalls and flash flood	Golodass Nallah	1 house fully damaged; farmlands and 8 houses partially damaged

DISASTER PROFILE OF KHAPLU

Settlement	Year	Event and cause	Nallah	Losses
Machilu	2002	Debris flow	Machulo Nallah	8 flour mills and 2 bridges
Machilu	2008	Debris flow	Machulo Nallah	7 flour mills
Farano	2010	Flash flood	Frano Nallah	8 houses and farmlands
Machilu	2011	Flash flood	Machulo Nallah	Flooding in about 300 *kanals* (1 *kanal* is equal to approximately 0.125 acres) of forest land
Machilu	2012	Flash flood	Machulo Nallah	The Hushe River floods and erosion affected about 20 *kanals* of farm and forest lands

DISASTER PROFILE OF PASSU

Settlement	Year	Event and cause	Nallah	Losses
Janabad	1974	GLOF event at Batura Glacier caused riverbank erosion	-	Farmlands and trees
Main Passu	1985	GLOF event at Batura Glacier caused riverbank erosion	-	3 houses, 20 terraces; fruit trees and cattle sheds
Main Passu	1985	GLOF	Passu Nallah	6 houses; cattle
Janabad	1910	GLOF event at Batura Glacier caused riverbank erosion	-	Houses, farmlands, orchards, and potato and wheat fields
Main Passu	2007	Cloud outburst	Passu Nallah	Dozens of cattle; farmlands
Main Passu	2008	GLOF	Passu Nallah	1 hotel and some houses
Main Passu	2009	GLOF	Passu Nallah	9 houses; forest land and fruit trees

DISASTER PROFILE OF SHIGAR

Settlement	Year	Event and cause	Nallah	Losses
Wazirpur Village	2000	Heavy rainfall and erosion	Shigar River	Ochards and farmlands
Wazirpur Village	2010	Flash flood	Bundu Nallah	3 houses totally damaged, 6 houses partially damaged; farmlands destroyed on a large scale
Wazirpur Village	2010	Flash flood	Chaangchungpa Nallah	Orchards and farmlands on a large scale
Wazirpur Village	2010	Flash flood	Chogolongma Nallah	Orchards and farmlands on a large scale; 50 houses
Wazirpur Village	2010	Flash flood	Bundu Nallah	3 houses totally damaged, 6 houses partially damaged; farmlands destroyed on a large scale

DISASTER PROFILE OF SHERQILLA

Settlement	Year	Event and cause	Nallah	Losses
Dirani	1975	Flood due to heavy rains and intensive snowmelt	Bechair Nallah	Farmlands, fruit trees, and timber trees
Sherqilla	1975	Flood due to heavy rains and intensive snowmelt	Dirani Nallah	Farmlands, fruit trees, and timber trees
Sherqilla	1982	Flood due to heavy rains and intensive snowmelt	Dirani Nallah and Bechair Nallah	Farmlands, fruit trees, and timber trees; cattle; the Sherqilla bridge; local irrigation channels
Sherqillla	1982	Flood due to heavy rains and intensive snowmelt	Dirani Nallah and Bechair Nallah	Power station; bridge; cattle and their shelter; and farmlands
Dirani	2005	Flood due to heavy rains and intensive snowmelt	Bechair Nallah	Farmlands, fruit trees, and timber trees
Sherqilla	2005	Flood due to heavy rains and intensive snowmelt	Dirani Nallah and Bechair Nallah	Farmlands, fruit trees, and timber trees; some cattle; the Sherqilla bridge; and the main local irrigation channel
Golo Dass	2005	Flood	Dirani Nallah and Bechair Nallah	Cultivated land
Sherqillla	2005	Flood due to heavy rains and intensive snowmelt	Dirani Nallah and Bechair Nallah	Power station; bridge; cattle and their shelter; and productive land
Sherqillla	2006	Flood due to heavy rains and intensive snowmelt	Dirani Nallah	Farmlands, fruit trees, and timber trees
Sherqilla	2010	Flash flood	Dirani Nallah	Orchards and farmlands

4. How does CBFEWS help in safe evacuation?

CBFEWS, an integrated system of tools (wireless version and a more advanced telemetric version), managed by communities, helps to detect and respond to flood emergencies (Figure 3). The system at the upstream location monitors the water level and transmits the information to the system at the caretaker's house. When the water level rises in the stream, an early warning is generated from the caretaker's house, and the trained caretaker interprets and relays the information to the downstream communities through pre-established channels in order to enable flood-vulnerable individuals, communities, and organizations to prepare and take action to reduce the risk of damage or loss of lives and property.

5. CBFEWS at scale

Handing over to government

The efficacy of the technology was already evident during a flood event in 2017 when the community members in Sherqilla had been alerted of an imminent flood. The value of this was then recognized by the Gilgit–Baltistan Disaster Management Authority (GBDMA) as well as by the community champions who had been appointed as caretakers of the flood early warning network. Later, in July 2019, following discussions in January of the same year, the CBFEWS was handed over to the GBDMA via an agreement signed between the government and other institutions to secure government ownership.

Based on the recommendations gathered from the pilot experience, it was also suggested that the CBFEWS be adapted into local disaster management plans. Considering that the current disaster management plan of Gilgit–Baltistan is largely focused on disaster response, learnings from the CBFEWS pilot interventions would be instrumental in drawing attention to disaster preparedness and adaptation with the help of innovative solutions in the context of a changing climate scenario.

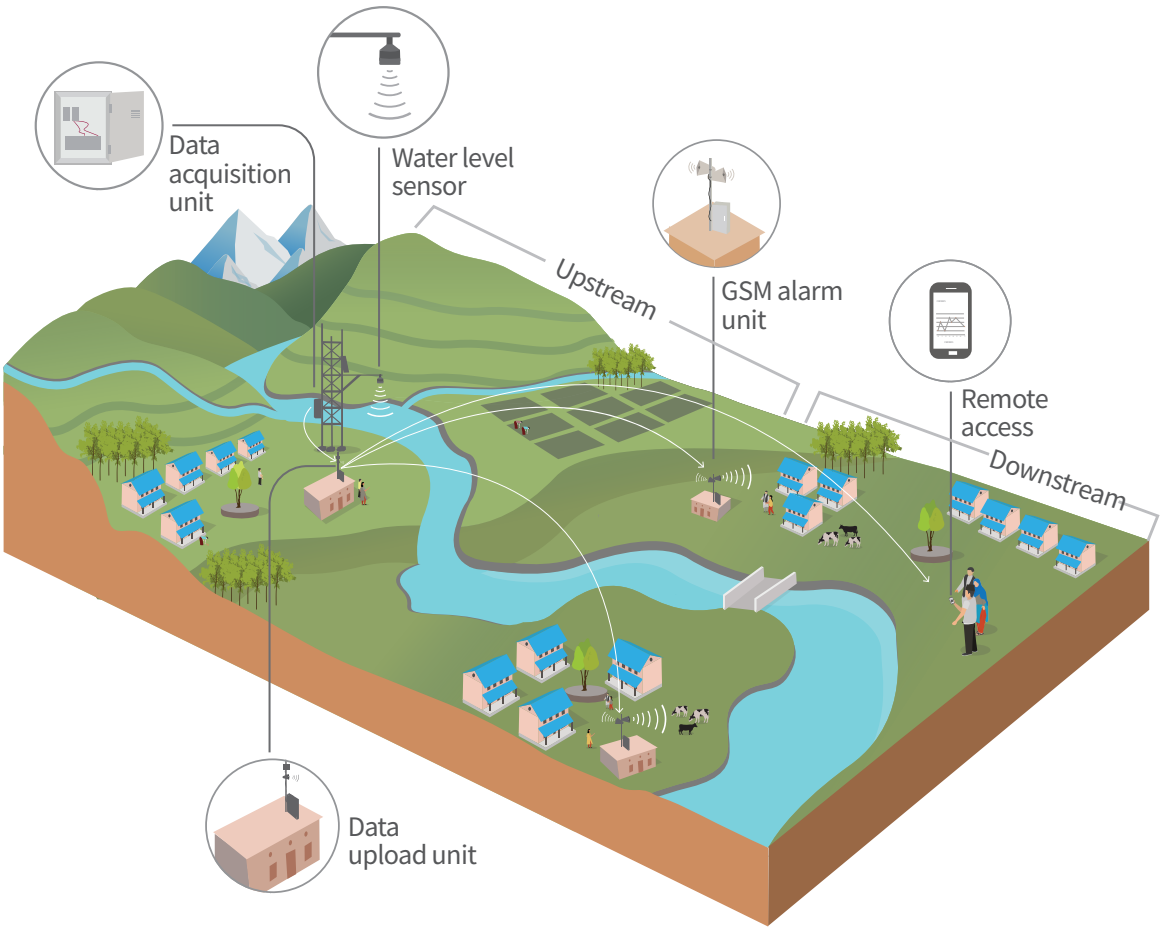
6. Learnings

Involving local agencies and relevant stakeholders

Involving agencies like the Gilgit–Baltistan Disaster Management Authority (GBDMA) from the very beginning of the planning and implementation processes of the CBFEWS helped in improving coordination, enhancing institutional capacity, building trust, and finally in handing over its ownership to the local agencies. This also paved way for identifying the elements that are required for its sustainability and upscaling.

In order to manage any flood-related hazard, it is imperative to strengthen the channels of early warning and data sharing among all the actors concerned. This is especially true in the case of a place like Gilgit–Baltistan, with its scattered population and remote areas; in such a context, there's also a likelihood of multiple stakeholders coming up with multiple solutions; this is bound to reduce the effectiveness of disaster response. Therefore, bringing innovation to

FIGURE 3 A SCHEMATIC DIAGRAM OF THE SYSTEM THAT MONITORS FLOOD LEVEL AND RELAYS EARLY WARNING THROUGH TELEMETRY COMMUNICATION



The Sherqilla success story

The efficiency of the CBFEWS technology was observed during a flood instance in the village of Sherqilla in 2017. The system activated the siren that communicated a flood warning to 2,800 people from 350 households. With an hour to evacuate, the villagers were able to take around 2,000 heads of livestock as well as valuables to higher ground before the flash flood hit the village. Fida Ali, one of the residents, says, "Before we installed the system, we would spend entire nights at the point of origin of flash floods so that we could provide situational updates to downstream villages. Now we can all sleep in peace."

Such a success highlights the fact that proactivity on the part of the community and proper coordination between the caretaker and community members is crucial for the timely relay of information. In Sherqilla, the CBFEWS technology has contributed to an increased sense of safety and disaster resilience among the villagers. As Zarnash Bibi, a teacher from Sherqilla, puts it, "Now, even when men go out for work, we can get on with our lives, go to school, and work knowing that the system will alert us well before the flood hits."

SHERQILLA CBFEWS

such measures requires collaborative action among the different agencies that are currently operating in the area. In this regard, harnessing the role of local agencies like the GBDMA is important in ensuring a smooth transition between the project implementers and local stakeholders, as well as for further scaling.

Currently, the government authorities within Gilgit–Baltistan, through the GBDMA, are engaged in disaster management plans. Here the focus is on building resilience within communities in partnership with multiple national and international donors. GBDMA is also a part of a project called "GLOF- 2", which potentially integrates learnings from the CBFEWS pilot interventions across the territory in partnership with the UNDP.

Working with the local communities in the areas of risk scoping and generation and dissemination of information

The local communities are the ultimate custodians of the early warning systems. Their involvement from its inception to demonstration is crucial. This also enhances their capacity and helps in identifying the necessary factors for the sustainability of the systems.

In this regard, ICIMOD's approach involves the inclusion of local communities in risk scoping, installation, and the operationalization of the early warning system, and in information generation and dissemination. That is why this approach is called the "Community Based Flood Early Warning System". To enhance the capacity of the local communities and relevant institutions, ICIMOD has conducted hands-on training and annual refreshers.

Working with the private sector has helped in technology transfer at the local level and in the outscaling of the CBFEWS via locally manufactured instruments

Utilizing the resources of local industries is important for two reasons. First, it promotes buy-in from local partners and stakeholders, including private entities, regarding the fabrication and upkeep of the CBFEWS components. Secondly, given the sensitivity of the region, things become easier if the systems fabricated by local manufacturers are used. In Pakistan, local engineering agencies have been working with national and local institutions in preparing instrumentations for institutions like the Pakistan Meteorological Department (PMD), the Water and Power Development Authority (WAPDA), and the Space and Upper Atmosphere Research Commission (SUPARCO). During the CBFEWS project's runtime, a local manufacturing agency, Burraq Integrated Solutions (BIS), was also able to manufacture a fully indigenized flood early warning system, which is not only economical but also readily available for further scaling up.

The sustainability aspects – financial, technological, and social – have to be considered from the very beginning of the project

The successful uptake of an intervention depends on its financial, technical, and social viability. Furthermore, local capacity and the availability of equipment ensure the sustainability of the intervention. The CBFEWS approach takes care of all these aspects to ensure wider scaling up and longer sustainability.

The CBFEWS has been piloted in an economical mode considering the local socio-economic conditions and the limited budgetary allocation for disaster risk reduction under the annual development plans. Meanwhile, the involvement of local vendors and indigenous producers has increased the potential for scaling out. In this regard, extensive deliberations have been conducted with the relevant stakeholders which have led to the evolution of CBFEWS technology as per local conditions and social needs.

Working with local communities, government partners, and other supporting agencies in enhancing disaster preparedness measures is a crucial aspect of the CBFEWS

An early warning system becomes more effective if the community under threat is aware of mitigation and response measures. Therefore, community mobilization, stockpiling of essential items, dissemination of information to the relevant stakeholders, and marshalling of first aid and rescue teams go hand in hand with the adoption of the technology.

The communities in Gilgit–Baltistan have been sensitized by multiple organizations over the past decade, but have been largely devoid of simple technological support. The CBFEWS has provided the space for testing these systems, while also factoring in community involvement. The case of Damas village is an example where inadequate monitoring of the technology and lax caretaking of the site, as well as limited collaboration between the caretaker and the community became a hindrance in efficiently using the system. But other Gilgit–Baltistan villages, owing to the active participation of community volunteers in safeguarding the technology and having stronger collaborative networks with the implementing organization, have been more successful

in responding to emergencies in a coordinated way. Most people in the vulnerable villages now believe that the flood early warning system has reduced psychological stress. They also mention that the system has helped them to plan better in terms of and managing flood risks. In addition, a series of regional hands-on training programmes on the installation and use of flood-monitoring devices organized by ICIMOD for caretakers, vulnerable communities, and representatives from local governments and NGOs, have been helpful in enhancing their technical expertise as well as conceptual knowledge about the CBFEWS. This has also enabled partners like the Aga Khan Agency for Habitat (AKAH) and WWF-Pakistan to further improve upon the technology through their independent efforts.

Notes

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